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ABSTRACT

The Organization for Economic Cooperation and Development (OECD) study, "Innovations in Science, Mathematics and Technology Education" (SMTE), documents 23 projects aimed at enhancing the appeal of science, mathematics, and technology education. The projects began in 13 OECD countries that believed that curricula must be more student-centered and more integrated across the sciences, embracing ethical and economic issues to match important social issues. This paper discusses the implications of reform efforts in relation to the didactical and pedagogical challenges that come with them, discussing how the changes affect the concept of teacher professionalism. A major trend in SMTE is broadening the curriculum framework beyond the subjects to incorporate social dimensions and interests students bring to learning the subjects. For example, the "Voyage of the Mimi" project emphasizes environmentalism, the "Urban Mathematics Collaboratives" highlights community self-help and development, and "Chemistry in the Community" searches for the social relevance of science. The German integrated science scheme, PING, emphasizes the development of responsible social action. The Norwegian science project develops an interest in science in the home. Innovative projects across OECD countries place SMTE in larger and more varied frameworks. The 23 cases provide insights and perspectives on this educational change. Analysis of the SMTE studies suggests that quality in education is dependent upon the positive interaction of each of the responsible and interested parties. (Contains 19 references.) (SM)

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CHANGING THE SUBJECT: THE CHALLENGE TO TEACHER PROFESSIONALISM OF INNOVATION IN OECD COUNTRIES

ED 422 298

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In the OECD study *Innovations in Science, Mathematics and Technology Education* (SMITE), 23 projects aimed at enhancing the appeal of these school subjects are documented (Black and Atkin, 1996; Raizen and Britton, 1997). These projects arose in 13 of the OECD countries because it was apparent that the curriculum must be more student-centred, starting from the concerns and experiences of the contemporary world rather than the traditional subject-centred approach, and more integrated across the sciences, embracing ethical and economic issues to match what is seen to be important in modern society, such as space research or environmental concerns.

A major trend in SMITE is the broadening of the curriculum framework beyond the subjects to incorporate social dimensions and the interests brought by the student to learning these subjects (James, 1997a; 1997b). So, for example, we see in the *Voyage of the Mimi* project a focus on environmentalism, in the *Urban Mathematics Collaboratives* a concern for community self-help and development, and in *Chemistry in the Community* a search for the social relevance of science (1). The German integrated science scheme *PING* arises within the development of responsible social action, and the Norwegian science project builds on an interest in science in the home (2).

Taken together, these examples show us that the innovative projects across OECD countries place SMTE in larger and more varied frameworks. Whilst such enlargement is not a new concept - being seen, for instance, in the constructivist approach and in the Science, Technology and Society movement - the trend across so many countries is significant. At the same time as curricula are changing, the challenges to teachers are increasing. New approaches in SMTE lead us to look at how teachers and students are responding. The 23 cases provide insights and perspectives on change.

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Teachers and reform

An important feature of the SMTE research is the voice given to teachers and students. Listening to them it becomes apparent that the nature of the subject taught and learned provides a familiar home for the work they do together. The innovations in these OECD countries involve quite significant changes in the way the subject is normally understood. For example, placing SMTE in a social dimension, or taking into account student interests - another way of accommodating the social dimension - means dealing with topics and classroom practices which are markedly different from the usual focus of the teacher's subject expertise, on subject-based progression in school work and student induction into arcane pedagogical rituals.

In this paper we discuss the implications of these reform efforts in relation to the didactical and pedagogical challenges which flow from them. We go on to consider how in practice these changes bear on the concept of teacher professionalism. We are able to understand the challenges to professionalism posed by innovations thanks to the fact that the OECD study is rich in the reflections of teachers who are immersed in the process of change. Much can be learned about the interaction between teachers and students and their engagement with others involved in redefining SMTE subjects in the curriculum.

Changing the Subject

The OECD project provides us with many examples of the way these subjects are changing. Challenges to familiar pedagogical practices and to the subjects themselves are common in SMTE. The move to subject integration, mentioned above, is a major example of a difficult change, as with integration of the sciences in the Spanish reform (Saez, 1995) and across science, mathematics and technology in Ontario, Canada (Robertson and Olson, in press). In these cases, not surprisingly, teaching unfamiliar subject matter created role insecurities for teachers, as did new approaches to teaching, which are perhaps still more challenging. Both of these disturbing elements can be seen where a new subject has been introduced. In Scotland, for example, technology education at the elementary level was introduced in conjunction with science. This integrated approach differed from that at the secondary level, giving rise to concerns about the preparedness of students for more advanced work in these subjects, and more generally about the transition from elementary to secondary (see Rudduck, et al., 1997).

The adoption of technology in lower secondary Dutch schools (Fransen, et al, 1995) raised controversy over the balance between theory and practical skills, and the intended emphasis on problem-solving was unfamiliar to many teachers whose experience comes from industrial arts and vocational education. Science teachers were disinclined to cooperate with technology teachers because the applications they wished to use in their own lessons were being appropriated elsewhere.

Teachers tell us that moving away from the safety of familiar subjects is not easy. Students tell us that they are secure with what is familiar. Teachers and students remind us that they are an integral part of the

overall change process. Where and how do they fit in? It is important to look at the commonplaces of the change process to begin to clarify our appreciation of the roles that they play.

The Commonplace Elements of Change and SMTE

Figure 1 shows commonplace elements of change and indicates the complex role teachers play in transforming the planned curriculum into classroom action. Teacher practices - themselves a reflection of teacher culture - are what bring curriculum ideas into operation. It is evident that policy intentions are going to be interpreted by the teacher, in a process which has been described as dialogical (Freire, 1973). We can see the results of conversations between teachers and developers in the actions in the classroom as innovative ideas are enacted there. Even if no face-to-face conversations occur, teachers engage with the ideas of the innovators as they make sense of and interpret what is being proposed, and acting on that teach. Given what we normally mean by the notion of teacher, it is hard to think it could be otherwise. Where teachers have not been significantly involved in the development stages, it is fairer to say that they enact curriculum policies rather than implement them (Reid, 1978).

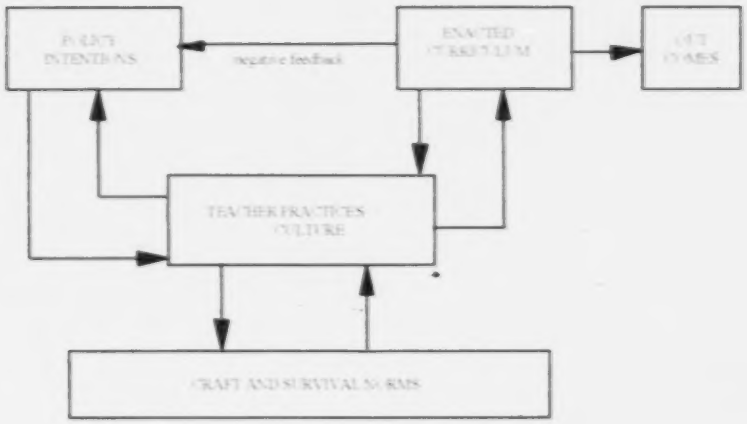

Figure 1: Commonplace elements of change

The enacted curriculum - what students experience - is immediately shaped by teacher practices which are in turn influenced by policies and by teacher values. The practices embody those values - they inscribe them. Policy intentions contribute to the context in which teachers shape practices, and may exert short-

term influence, particularly on outcomes which can be measured. But to fully understand the experienced curriculum we have to consider the survival and craft values that underlie the practice. Ultimately it is those values which will most influence outcomes. Here policy and research are not without influence, but any change they may bring about is longer term.

To call teaching an enactment simply bespeaks of the complexity of giving effect to policies in real classrooms. Policies are intentions - perhaps to be seen as script and with stage directions - but teachers have to conduct lessons on the classroom stage. Given the importance of teacher-culture we well might ask: "On what do teachers base their interpretation of innovations and their enactment of these in the classroom?" Let us turn to this question now.

Teacher Culture

Teacher culture is comprised in part of what we can call craft and survival values (see Fig. 1). They embody personal and professional values and concerns which reflect the realities of the role - a role both complex and difficult. Comprising survival values are matters to do with self-confidence, a sense of efficacy, authority and credibility (Olson, 1992). Craft values involve issues such as subject knowledge, pedagogical capability, reliability, trust and virtues of professionalism (Sockett, 1992; Hansen, 1995). The values guide the practice of teachers. New ideas may threaten the balance established between survival and craft values; they may threaten the values themselves.

These values are not often expressed - they lie behind and are shaded by formal statements of teacher purpose or concerns. For example, teachers often complain of a lack of time in relation to innovation. Lack of time acts as a code word hinting at other concerns which, though difficult to articulate, are important to teachers. One of the reasons these values are difficult to express is that teachers experience conflict between craft and survival values. Yes, they want to do the best work possible but often the circumstances do not permit them to do that (Hansen, 1995).

Both conditions of work and the nature of personal and professional values can be examined in more detail in the light of the challenge of innovation. In defending survival values teachers run the risk of being accused of a lack of professionalism, but often the basis of the criticism does not take into account the complexity of the work. We see such criticism in the accounts of teachers' beliefs made by social scientists, using criteria taken from outside teaching (see, for example, Lortie, 1975). Concerned about the disparity between desirable conditions of work and reality - and finding this disparity unresolvable - teachers may be tempted either to romanticise their work or to avoid reflecting on it (Klette, 1997), thereby impeding effective change. Conversely, reflective dialogue in association with innovative ideas can give rise to professional growth, as existing frameworks found wanting are revised and become more powerful in coping with the new realities.

Thus the change process itself can profit from teacher reflection and is the poorer without it. One of the

reasons why research studies like SMTE are undertaken is to obtain such feedback about innovative efforts. Negative feedback from teachers (see Fig. 1), that is to say information about the problems and challenges of innovation, is useful knowledge with the capacity to effect improvements as development proceeds. Evidently this hoped for outcome will only arise as teachers have the capability to function in this way. Questions about teacher education are important here and the process of innovation cannot be detached from them. Too often teacher education is seen as no more than training to implement the innovation, whereas there is need to develop the analytical frameworks and skills needed to reflect on existing practice and the implications of change (see Westbury, 1995).

In the German integrated science project *PING*, for example, a *systemic* approach was adopted in which negative feedback from teachers to the development team acts as a *disturbance* and so initiates change by self-correction (Lang, 1997, Hansen, 1997). Significantly, the scheme has not produced a textbook, but rather uses work sheets which are subject to periodic revision in the light of experience. Systemic approaches are often used to explain change in complex social and environmental systems (Krohn, et al, 1990). The systemic view of self-organisation - the theoretical basis for the PING project - depends on disturbance to the system initiated by external or internal feedback, an important prerequisite for which is *informational openness*. Hence a basic rule for PING teachers and researchers - and for teacher training - is the use of grounded practice (Projektgruppe PING, 1996), whereby information about project planning is made readily available to all whose actions will subsequently be affected by it.

The point is illustrated in an interview with one of the researchers in the German case study (Hansen et al, 1995, p. 25): 'That is why we created the project group that met regularly and which had to follow a self-set of rules. There had to be a place for reflection: for research to move to schools and for school practice to inform research. The framework that seemed most useful for institutionalising this intention was in-service training'. We shall return to the PING project later when we consider how the process of innovation can allow professionalism in education to be enhanced.

It is worth noting here that the feedback metaphor comes from electronic circuitry, where negative feedback exercises a stabilising influence, whereas positive feedback might send a system out of control. The negative feedback provides information about how the system is responding to change and provides a basis for formative adjustments. Positive feedback, on the other hand, carries little information useful for decision making. The danger of depending on positive feedback can be seen in the field of computers in education, where much written material acts as a promotion for computer-based education (Miller and Olson, 1996), rather than illuminating the innovation; feedback merely stimulates more investment without guidance about what changes need to be made. In curriculum development the most important feedback may be negative, as with the powerful message coming back from SMTE, that the concerns of teachers and students involved in innovation need to be addressed at every stage. In general, however, constructive negative feedback is scarce, and consequently the opportunity to learn from experience is diminished.

Reform processes which did not enter into dialogue with teachers - such as the teacher-proofed projects of the 1960s - were the less successful in consequence. We can see in SMTE vigorous efforts to involve teachers and students in the process of change, in consequence of which the culture of the teacher and of the classroom is better understood and better heeded. The voices of teachers and students remind us of the issues important to them and of the intricacies which attend change in classroom settings. They remind us that change intended to bring opportunity to enhance the quality of the educational service may also be threatening and impose considerable risks - the word *scary* was often used as the cross-case analysis of SMTE evolved. Why do teachers sometimes react like this? In order to understand it is important to look at the didactical and pedagogical challenges which innovation brings.

Innovation and the Challenges to Practice

The didactical challenge

We have noted one of the major innovations found in the studies, that of integration across subjects, for which often the necessary developmental work has had to be undertaken by the teachers themselves. Such development involves the ability to analyse contents for thematic use, which is a sophisticated didactical skill. Being able to balance the need to develop subject-based conceptual development - while at the same time showing the links amongst subjects and highlighting socially relevant connections - is a major challenge often overlooked in calls for integration. Furthermore, given the prototypical nature of these materials, teachers are called upon to use formative and summative evaluation skills in assessing how well they are functioning. How appropriate are they? How do they need to be modified? Existing text books are often of no use when planning integrated or combined units and teachers have to access alternative sources, which may include making use of the Internet. These sources may come from special interests groups whose intention is not educational but public relations based, so that teachers will need to assess the materials and see where their educational potential lies. To do so is an onerous and sophisticated task which takes time.

In attempting to implement innovations teachers are called upon to change their attitudes to their work. Take the case of extending the use of information technology, which is likely to involve collaboration with others in scheduling and planning the best use of scarce resources and in ordering more software. This implies certain skills in collaborating with others which classroom work may not often require. Using computers in the classroom to teach subjects in new ways can be risky (Olson, 1992), though they offer opportunity and are as we have seen an important element of change.

The new technologies can have profound effects on classroom practice, as in a number of countries in the study where calculators and computers have been introduced to mathematics classes. What happens when

these devices are used? In the Japan study, for example, it was found that teachers are encouraged to use calculators and inquiry methods of teaching but hesitate because such activity has not been supported in the textbooks or in examinations (Black and Atkin, p. 135).

Or again, computers can speed up calculations and data analysis but they may slow down and thereby disadvantage students who have difficulties in learning software routines. Again, teachers may hesitate. Evidently the use of these new technologies calls teachers to reflect on their practice (Miller and Olson, 1994). What elements of existing practice are no longer needed? What subject content may be redundant? Given the importance to teacher-culture of familiarity with content, it takes courage and honesty to reflect critically in such ways.

An almost universally important outcome of schooling is the acquisition of credentials. Schools need the support of employers and tertiary institutions to legitimate the courses provided for students. When the credential system is unsympathetic to innovation, or during a period of transition, risk for schools exists. The credibility of teachers may be brought into question and their work affected, as was seen in the history of the UK Schools Council Integrated Science Project (Olson, 1982) and can be seen in SMTE. For example, the integrated science scheme developed in California had to obtain the approval of the University of California and out-of-state universities on a case-by-case basis. Or again, in *Chemistry in the Community* the subject is taught with reference to social issues, which means that traditional chemistry may not always be covered, leaving tertiary institutions uncertain about the efficacy of the course as a preparation for further work in the field. The concerns here were ameliorated, however, because the innovation was strongly supported by the influential American Chemical Society.

Pedagogical challenges

The value messages present in socially responsive projects may cause teachers unease. Rather than being pre-eminently a subject expert, a teacher may now be called on to adjudicate in debates about the worth of science and technology in society. Similarly, taking seriously student interests in the subject may lead to open-ended explorations with delicate or sensitive value-laden implications. This less-clearly articulated role may unsettle teachers, for whom the security of well-tried expertise is lost. The demands for a changed teaching role bring new attention to questions about the nature of teacher professionalism (James, in press). Often even now the teacher acts as an authority figure, possessing a superior level of subject competence, but in the knowledge society and given the demand for student autonomy in learning this notion is becoming increasingly difficult if not impossible to sustain. The teacher can, however, become a powerful role model as someone committed to lifelong learning, who has acquired the skills of learning and a respect for knowledge, who is well connected with and acknowledged by others who are influential in the community, who knows whom to approach for particular areas of expertise and how to evaluate what is offered. Students who see their teachers networked into society and interacting on such a basis of

reciprocal recognition will find it natural and desirable to want to do the same

Teachers who are called upon to face such major transformations may become uncomfortably aware that the new technologies bring bane as well as blessing, with new classroom problems to be resolved and new protocols established. Their concerns need to be heard. In the longer term, and as educational software becomes more sophisticated, we might anticipate unparalleled strategies for individualised learning, with a considerable shift for the teacher from whole class activity to tutorial work and the management of learning. Already in Spain and in the US *Pre-calculus*, student work in small groups is part of a new approach to learning. For traditional teachers accustomed to leading a whole class, this greater degree of student-centredness has often proved unsettling.

Teachers are expected more than hitherto to find out how students understand their world. How can this be done other than by talking to students and by listening to them? For some teachers holding open classroom discussions poses a major challenge, as does re-casting their subject matter to present it in problematic terms, when they are more used to providing authoritative explanations. How can students learn to solve problems unless they are presented with real problems to solve? This more student-centred approach creates risks for the teacher, who has to be willing to abandon the familiar persona of the expert in possession of all the answers. A certain humility is required to achieve this, and for some the attainment of this may not be a comfortable process.

As we suggested above, the teacher is called to act as a role model of the honest, reflective person, which may mean showing to the student that the answer is not always immediately clear; it may involve accepting that there are zones of grey, a message that students perhaps do not want to hear. It takes courage to step down from the position of authority (MacIntyre, 1983). It is risky. Given the serious challenges innovation poses to teacher professionalism, it is worth considering the risks involved from the teacher's point of view. What are these risks?

Teacher professionalism and the risks of change

We have already looked at risks due to new definitions of subject matter and new practices that flow from that. Other risks might be added, such as those arising from reactionary community politics or fundamentalist influences, but those illustrated here are common to the lot of most teachers. How do the risks arise?

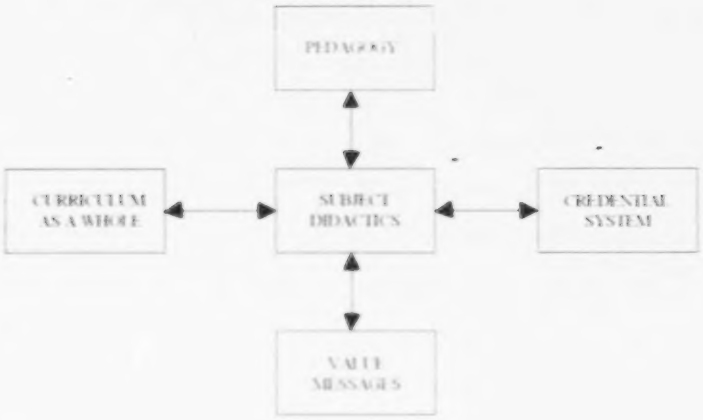

Fig. 2: Elements of Professional Risk

At the centre of the work of the teacher is the way the subject is used in the learning situation. Arrayed in action around the subject are pressures to shape it this way or that which give rise to risk. We have earlier noted the strong forces acting to bring separate curriculum subjects more into contact with each other, and the effect on the structure of a subject caused by pedagogical approaches such as constructivism. The credential system brings strong influence on didactics, especially from the universities. Parents may lobby, perhaps to secure greater use of computers or more attention to basic skills. Environmentalism, a source of value messages, presses in. Take the case of Japan where students found that science activities dealing with their local environment were much more interesting that activities in which the material was divorced from their experience. As one teacher said :"Pupils began to find relationships between the neighborhood and themselves. Pupils began to have an attitude to love nature (Black and Atkin, p. 70). The upshot is that traditional subject didactics is under threat, which implies risks for teachers who have invested heavily in a particular approach, and therefore for students also.

It is true that changes in these zones may rapidly be liberating for some, and may gain general acceptance in the longer term. This, however, offers no consolation to others not at ease - perhaps a majority - who

are charged even now with the responsibility for the only formative education a generation of young people will receive. New approaches introduced without considering these risks can unduly disturb the comfort teachers and students feel with well-tried content and methods. Furthermore, how can teachers develop the ability to undertake the necessary reassessments of their work, to review and critique existing practices? We need to consider the challenge of innovation to teacher professionalism and to the education of teachers as professionals. Here again it is instructive to look at the case of *PING* where teachers played an important role in the development of the concept and implementation of integrated science in the middle school.

As we have seen, the PING project is a collaborative activity of teachers, researchers and teacher educators who want to make science more meaningful to students, to develop professionally, and to evaluate their professional practice and beliefs against classroom outcomes and common curricular practice. It started, not as a change strategy from above, but as the initiative of teachers, who were concerned about their lack of competence to teach integrated science in comprehensive schools. A team approach to this problem was adopted. The team decided that the way to make science more meaningful for the majority of students - who will not be physics, chemistry, or biology specialists - was by choosing topics to illuminate the relationships between people and the natural world. Work sheets for each theme suggest a variety of activities inside and outside the classroom and strategies for student learning.

PING development involves teacher collaboration in school and institutionalised contacts in regular teacher-training workshops. Moreover, teachers and researchers often meet in the project and there are regional meetings comprised of researchers, teachers, teacher trainers and representatives from different federal states. Teachers in the research and development group judge the cooperation with other colleagues in school to be a central part of the PING project. As one teacher said: 'Cooperation in the school is an important aspect of our everyday work. If I want to work effectively I must cooperate locally at the school. And stable groups in the schools have to be established to facilitate the everyday work. To make everyday work efficient, that is the thing I have experienced as productive in PING.' (Hansen, 1995).

Teachers interact with students during a lesson or project in order to agree on the selection of PING materials and procedures for independent learning. This kind of partnership involves a change in the teacher's role; student input is important. As one teacher from the development group with substantial experience with integrated science teaching said: "I need not give an answer immediately; instead I must use my knowledge to open a gate for students to their own understanding." This student-centered view is a chance for teachers to learn more about new ways to integrate and to promote students' learning. But we also have to realize that teachers cannot take this chance without a background of professional preparation.

So far, teacher training for integrated science education has only been offered for in-service (INSET) in schools or training centers. There are no requirements in pre-service, and outside PING there is a lack of material for integrated topics. This means that in-service courses about integrated science teaching have to begin from scratch and have to promote conceptual change from disciplinary to integrated thinking. The change is difficult for most teachers because of the rigid routines of disciplinary teaching, lack of material support for integrated topics and a different style of student-centered teaching and the need for reflection on the practical consequences of teaching in these new ways.

Teacher in-service training is a collaborative activity involving cooperative work sessions dealing with selection and use of materials, concept development, lesson planning, use of feedback from classroom practice and evaluation for material revision. Basic problems and questions for general understanding are discussed.

A network for planning, information exchange, material development and revision (KORB) is maintained by the research institution IPN. The feedback to this coordination network leads to further written exchange after the basic ideas have been clarified and a core of common knowledge established. Consequently ,the main function of network collaboration is to elaborate ideas already developed and to see that they become established in the classroom. The original creative impulse for development primarily occurs in face-to-face meetings. Both functions: conserving ideas and originating them need to be integrated for innovative and continuous professional development.

The PING case and others in the OECD study suggest that the culture of specialist teachers is much influenced by the approach adopted for their subject. Shift the subject definition or the nature of the related pedagogy and teachers will be required to reflect anew on their practice. There is opportunity here for growth, notably as suggested above in terms of professionalism, but also risk of anxiety and aversion, with failure to accommodate to change or to enter into dialogue. Our aim must be to enhance the growth potentials of innovation while minimising the risks. What, then, can be done to ensure the wellbeing of an educational system in change, especially at the focal point of enactment - the teacher? The points which follow are developed from the insights first adumbrated within SMTE in relation to such concerns, when so often the role of the teacher was seen to be crucial. Unashamedly, therefore, this concluding section is presented from the perspective of aspects of teacher professionalism and of what an enhanced view of this might entail.

While the initial education and training of teachers is of obvious importance, it may, paradoxically, be most appropriate to attend first to in-service needs, so that sharpened perception here may subsequently influence the foundational provision. Regrettably, existing formats for INSET often place teachers in a

subordinate position. Rarely is the agenda set by teachers and dialogue is often absent as experts give expensive talks. There may be a prior need for teachers to attend courses on group dynamics and assertiveness, in order for them to become equipped to play a fuller part in setting INSET agenda. It is teachers who shape new ideas into workable form and educational opportunity, and whose insights, therefore, are needful in the planning and delivery of INSET programmes (see Watson, 1997).

Certain INSET requirements are immediately apparent. There will be need to consider the implications of integrated work, and how teachers may best be enabled to collaborate and share their differing subject expertise. How is group work amongst students to be managed effectively, especially by teachers who are accustomed to exercising unquestioned control over classroom agendas? But these are no more than examples. Within the availability of limited resources, priorities must be established for INSET, priorities which accord with teacher needs.

Teacher experience gained in the process of reform can itself lead to increased professionalism, allowing teachers to become better able to take part in policy formation, in the development of educational theory and research practice. We see in the cases examples of how teachers can work with others who are not teachers to develop curricula, or with each other in refining curricular ideas, can interpret student responses to reform, identify missing elements in reform policies, or give better nuanced meaning to the significance of changes in pedagogy and routine (James, 1997b). All such contributions are themselves an enhancement of the notion of teacher professionalism, whilst the critical feedback which can come only from teachers is a vital ingredient to reform. The outcome of such exchange is a more adequate praxis.

Educational research agendas have not often been much influenced by teachers, so that the ability of teachers to reflect on and evaluate educational policies and reform is underdeveloped. In consequence opportunities for professional growth and for improvement in school programmes are less than they would otherwise be. If there were to be greater involvement it would benefit the researchers as well as the teachers and the schools, allowing them to grasp more comprehensively the complexity of classroom work. We can see in many of the OECD studies how teacher feedback worked. In some we can see teacher response institutionalised, as in the California Science project. As yet, however, there is usually little opportunity for teachers to comment, though Web pages and e-mail might open up new possibilities, given adequate access and encouragement. Teachers can themselves conduct research, but whether that is a fully realistic idea remains debatable - research requires considerable distancing from what is going on, which is difficult to achieve in parallel with teaching, though more feasible with secondment for the purpose; the action researcher idea should be examined critically (Bottery, 1997). For the present, however, the objective must be movement towards more open communication between teacher and researcher, based on greater collegiality in a common enterprise. On this basis each would benefit and the resulting synergy would augment the profession as a whole.

Perhaps it is time to review the way we describe the process of educational change and innovatory development to make more allowance for the important role teachers themselves play. Perhaps

educationalists collectively need to develop a more appropriate language for their practice, not one borrowed from fields outside, such as business or economics, in order to achieve effective dialogue and address their common concerns more adequately. Rather than thinking of ideas for curriculum and pedagogy coming from central offices or external authorities, as required new techniques or products ready for adoption, it would be better to recognise that they come from a number of sources and that they never come fully formed. For the clear message arising from the analysis of the SMTE studies is that quality in school education is dependent on the positive interaction of each of the interested and responsible parties, be they policy makers or academics, experts in practice or pedagogy, notables within the business and social community or informed members of the public at large. No one sector has the judgement or the vision to act independent of the others. It is the business of government to establish the framework for effective dialogue, wherein the various parties may relate on a basis of mutual respect and acknowledged inter-dependence. Therein the professionalism of the teacher will be displayed and the voice of the teacher deservedly be heard.

Notes

1. Details concerning these projects can be found in Raizen and Britton (1997).

2. Brief descriptions of all case studies and sources of further information can be found in Black and Atkin (1997) and on the world wide web at
<http://www.oecd.org/els/edu/ceri/objective/6/smte/smte_home.htm>

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